Abstract Submitted to the
International Conference on Strongly Correlated Electron Systems
University of Michigan, Ann Arbor
August 6-10, 2001

Partial Ferromagnetism in Semimetallic Systems: Numerical Calculation and Rigorous Proof

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Stimulated by the high-temperature weak ferromagnetism recently found in doped hexaborides ($D_{1-x}La_xB_6$, D=Ca,Sr,Ba), ferromagnetism in semimetallic systems has attracted great interest. To explore whether electron-hole systems favor ferromagnetism, we have numerically investigated semimetallic two-band models in one-dimensional(1D) and infinite-dimensional systems. By performing the density-matrix-renormalization-group calculation and the dynamical-mean-field theory, we have found that the partially ferromagnetic state appears by the interaction of the order of the band overlap. We have proposed a mechanism of ferromagnetism which works around semimetallic band structures even without doping. The mechanism is an extension of the double exchange mechanism, which we call the extended double exchange (EDE). To show how the EDE operates, we present a rigorous proof of the partial ferromagnetism using the Perron-Frobenius theorem, which works for a 1D strongly-correlated electron model. The present theory provides the first proof of the metallic partial ferromagnetism for a model having only itinerant electrons.